



# NOAA Involvement in Long Island Sound

March 1987



**U.S. DEPARTMENT OF COMMERCE**  
**National Oceanic and Atmospheric Administration**  
NOAA Estuarine Programs Office



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**National Oceanic and Atmospheric Administration**

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In the 1984 renewal of the Clean Water Act, Congress initiated a major program designed to improve the quality and management of our estuarine resources. The program is taking place in selected estuaries of national importance, including Long Island Sound. The Long Island Sound Study began in 1985 with a Congressional appropriation of \$1 million. The Congressionally mandated goals of the multi-year project are (1) to assess the principal factors having an adverse effect on the environmental quality of Long Island Sound (as perceived by both scientists and users), and (2) to develop and implement a management program to improve the Sound's water quality.

The Environmental Protection Agency was charged with establishing the program, after consultation with the States of Connecticut and New York, the National Oceanic and Atmospheric Administration (NOAA) and other appropriate Federal and state agencies, and interested persons.

NOAA has participated actively in Long Island Sound Study since its inception; NOAA scientists and managers serve on several committees administering the project, and NOAA researchers are conducting a number of studies on the Sound and its resources. Some of these studies are partially supported by Long Island Sound Study whereas others are funded wholly by NOAA.

To further assist and support the goals of the Long Island Sound Study, this document was prepared by the NOAA Estuarine Programs Office (EPO) to describe the full range of activities that NOAA is conducting in Long Island Sound in 1985-1987. To facilitate coordination between NOAA and the Long Island Sound Study, we have designated individuals both on-site and in Washington, D.C. to coordinate NOAA's future activities in Long Island Sound.

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## NOAA ACTIVITIES IN LONG ISLAND SOUND 1985 - 1987

### I. INTRODUCTION

The importance of Long Island Sound to Connecticut, New York, and the Northeast cannot be overestimated. For years it has provided surrounding populations with seafood and recreational opportunities and has served as a route for transportation and commerce.

Unfortunately, Long Island Sound also has served as a receptacle for human and industrial wastes. The history of waste disposal in the Sound is a long one; the area was settled very early, and the industrial revolution led to a number of factories located along its shorelines. The rapidly developing populations along the Sound used its waters for disposal of wastes; this problem was exacerbated by transport of New York City wastes into the Sound via the East River, which connects the Sound with New York Harbor. In recent years, sewage treatment plants discharging into the East River have been implicated in environmental problems in the western Sound.

Other contaminants also have been introduced into the Sound by human activities. Scientists have made much progress toward an understanding of the threats that these contaminants pose to human or environmental health, but much remains to be done. Environmental managers charged with protecting the quality of Long Island Sound and its resources continue to require information from properly-designed studies and programs, some of which are being conducted under the auspices of the Long Island Sound Study.

NOAA programs in the Long Island Sound provide information to address some of the major problems facing the region. They are designed to characterize or describe the current state of the Sound, to conduct research to fill information gaps, and to provide this information to agencies responsible for managing natural resources or water quality. NOAA's estuarine programs in the Long Island Sound are conducted primarily by the National Marine Fisheries Service, the Office of Oceanic and Atmospheric Research (including Sea Grant), the National Ocean Service, and the National Environmental Satellite, Data, and Information Service. These programs are described below.

In addition to the programs described in this document, NOAA conducts generic estuarine studies or programs that can be applied to Long Island Sound. For a description of the full range of NOAA's estuarine programs, contact the NOAA EPO for a copy of the companion document, NOAA's Estuarine Capabilities Paper.

## II. ESTUARINE CHARACTERIZATION

Estuarine characterization is the essential first step in describing the health of an estuarine system. To characterize an estuary, existing information on the physical environment and on the resident plants and animals must be identified and analyzed. This step reveals where additional data need to be collected to fully evaluate the system.

NOAA sponsors a number of efforts designed to characterize different aspects of the Long Island Sound system.

### A. Data Archives and Data Assessment

#### The National Estuarine Inventory (NEI)

The NEI is the framework in NOAA's efforts to assess the health of the Nation's estuaries. It identifies all large- and medium-size estuaries within the contiguous United States; compiles a data base of their important physical, hydrologic, biological, and economic characteristics; and specifies a commonly-derived spatial unit, the estuarine drainage area, by which data are compiled. Ninety-two estuaries were identified in the NEI and account for approximately 90 percent of the freshwater inflow. The National Estuarine Inventory Data Atlas illustrates characteristics of the estuaries identified in the NEI. Volume 1 of the Atlas describes the physical and hydrologic characteristics and Volume 2 describes land use characteristics. Among the estuaries identified in the NEI is Long Island Sound. Additional projects being conducted by NOAA within the NEI framework or being adapted to that framework are described below. When the NEI data base is completed, it will be used to make comparisons, rankings, statistical correlations, and other analyses related to resource use, environmental quality, and economic value among estuaries.

#### National Coastal Pollutant Discharge Inventory (NCPDI)

The NCPDI is a data base and computational framework containing discharge estimates for all point, non-point, and riverine sources of pollutant discharges into the estuarine, coastal, and oceanic waters of the contiguous United States (excluding the Great Lakes). Pollutant discharge estimates are for a variety of contaminants including nutrients, metals, petroleum, hydrocarbons, PCBs, chlorinated hydrocarbon pesticides, fecal coliform bacteria, particulate matter, sludge, oxygen-demanding materials, and wastewater flow. The framework will enable nationwide assessments of the impact of pollutant discharges into these waters under different assumptions about economic conditions, pollution control options, meteorologic and hydrologic conditions, and public policies. The NCPDI contains three components: the Gulf of Mexico (completed March 1981); the east

coast (completed January 1985); and the west coast (scheduled for completion in March 1987). NCPDI data for pollutant categories of interest such as nutrients and pesticides will be compiled for the 92 estuaries of the NEI in 1987.

In 1986, as part of the U.S. Environmental Protection Agency's (EPA) National Estuary Program (NEP) Long Island Sound Study, EPA asked NOAA to compile a data base of pollutant discharges entering Long Island based on the NCPDI. As part of the development of the data base, the original NCPDI discharge estimates for point sources (based on year 1982) were updated to reflect conditions in 1984. Summaries and interpretations of these detailed discharge data are contained in a NOAA report entitled The National Coastal Pollutant Discharge Inventory: Estimates for Long Island Sound. One of the findings of this study was that, for most of the pollutants evaluated in the data base, rivers entering the study area contributed the greatest portion of the total pollutant load estimated to be discharged to the Sound; wastewater treatment plants within the study area contribute the next largest portion, and the urban runoff contributed the third greatest amount.

#### National Coastal Wetlands Data Base

NOAA is developing a national coastal wetlands data base through use of a systematic grid sampling procedure on wetland maps produced for the National Wetlands Inventory (NWI) of the U.S. Fish and Wildlife Service (FWS). Fifteen habitat types are recorded by 45 acre cells on 1:24,000 scale wetland maps. Acreage estimates and color maps for one or several NWI maps can be produced. Grid sampled data can be intersected with digitized boundaries such as counties and estuarine drainage areas as defined in the NEI to produce acreage summaries and maps for specific units of interest. Approximately 3,300 of the 5,000 NWI maps required to complete coverage of the Nation's estuaries are currently available. Grid sampling of coastal wetlands from Maine to Connecticut, including the Connecticut portion of Long Island Sound is completed. These data will be integrated into the NEI and used in conjunction with other information such as coastal pollution, distribution of estuarine fishes and invertebrates, and the status of classified shellfish water to develop a national estuarine assessment capability. Prior to beginning this inventory, NOAA examined existing state and local wetland inventories and summarized the distribution of four wetland types -- salt marsh, fresh marsh, tidal flat, and swamp -- in coastal counties of 22 coastal states, including Connecticut and New York. This work is described in a January 1986 NOAA report entitled An Inventory of Coastal Wetlands of the United States.

## National Shellfish Register of Classified Estuarine Waters.

This project compiles nationwide information on the classifications of shellfishing areas by state authorities. These areas are classified predominantly on the basis of coliform bacteria levels as approved, prohibited, conditionally approved, restricted, or nonshellfish/nonproductive. NOAA and the Food and Drug Administration jointly prepared the 1985 Shellfish Register and NOAA has begun improvement of the data presented in the 1985 and previous Shellfish Registers. Classification data from 1971, 1975, 1980, and 1985 have been reorganized into the 92 estuaries on the east, west, and Gulf coasts that comprise the NEI including Long Island Sound. The data also have been corrected for areas that were classified for reasons other than water quality. They are summarized in a December 1986, NOAA report entitled National Estuarine Inventory: Classified Shellfish Growing Waters by Estuary. Based on these data, Long Island Sound experienced approximately a one percent increase in prohibited and conditionally approved waters since 1980 and a one percent decrease in approved waters. NOAA, in cooperation with shellfish producing states, is now identifying the pollution sources of areas that are limited to the harvest of shellfish.

## Living Marine Resources

NOAA is developing information on the distribution and abundance of living marine resources in the Nation's estuaries. The information will be developed for approximately 150 species and will initially be organized by the three salinity zones depicted for each estuary in Volume 1 of the National Estuarine Inventory Data Atlas plus additional estuaries of biological importance. The project is being conducted in three phases: phase one, the west coast; phase two, the Gulf of Mexico; and phase three, the east coast which includes Long Island Sound. The overall feasibility of the project is discussed in the NOAA report National Estuarine Inventory, Living Marine Resources Component, West Coast. The data for Long Island Sound are scheduled to be available late in FY 88.

## Shoreline Characterization

This NOAA project will develop information on shoreline characteristics for each of the 92 estuaries of the contiguous United States identified in the NEI as part of efforts to develop a national estuarine assessment capability. The project identifies eight shoreline types, dredged channels, and dredge material disposal sites from NOAA nautical charts and estimates the relative extent of each shoreline type along the estuary. These data will eventually be integrated into an estuarine classification scheme to explore relationships between estuarine habitats and their susceptibility to anthropogenic inputs to the estuarine environment.



## Water Quality Screening Model

A generalized, water quality "screening model framework" was developed for application to estuarine systems included in the NEI. This model framework was designed to use available data and can be applied to most systems in a matter of days. It is based on 8 years of experience with an oil spill simulation model developed by NOAA. The model is a steady-state, two-dimensional formulation composed of a hydrodynamic component that estimates circulation based on system geometry, freshwater inflow, and tidal action and a water quality component that estimates pollutant concentrations based on advection and dispersion processes. It is now being applied to Pamlico and Albemarle Sounds and has already been applied to Breton Sound, Louisiana, and Long Island Sound.

## Oxygen Depletion in Western Long Island Sound

One of the environmental problems in western Long Island Sound in recent years has been recurring hypoxia in bottom waters during the summer months. Despite several state and local monitoring programs in the Sound, however, the extent and duration of oxygen-depleted waters are not well understood. By compiling and analyzing historical water quality data, NOAA investigators are mapping the extent and duration of this oxygen depletion and investigating the factors that cause it. A link had been suggested between oxygen depletion in Long Island Sound and New York City wastewaters entering the Sound via the East River. This project has been partly funded by the Long Island Sound Study and is serving as a baseline against which to compare new data on hypoxia being collected for the Long Island Sound Study in 1986 and 1987. In addition to the environmental analysis, an informal report detailing sources of historical and current data on water quality in the western Sound (with special emphasis on oxygen content) entitled Data Characterizations for Western Long Island Sound was issued in June 1986 by NOAA.

## Historical Changes in the Oceanography of Long Island Sound

Long Island Sound is one of the most intensively studied bodies of coastal water in the United States, yet disagreement persists on the health of the Sound's ecosystem. To address this question, NOAA funded Sea Grant scientists are conducting studies on the state of the Sound today and comparing their new data with those collected in the 1950s. This comparison of historical and current data bases on major oceanographic parameters of Long Island Sound will reveal where there has been significant change in the Sound ecosystem.

## Data and Information Referrel Service

To assist with data and information needs in the Northeast, NOAA maintains a staff person in Woods Hole, Massachusetts to work with local and regional users. This representative can provide information about marine science activities, personnel, and data sources pertinent to the Northeast, including Long Island Sound.

### B. Stock Assessment and Fisheries Statistics

Effective management of fisheries resources requires an understanding of the factors affecting the size and health of estuarine populations of finfish and shellfish. In a heavily populated area such as the region surrounding Long Island Sound, pollution may have a significant impact on reproductive success and recruitment of finfish and shellfish. An evaluation of the linkage between pollutant effects on individuals and on entire populations is one application of stock assessment research. The Long Island Sound Study is funding NOAA to conduct such a stock assessment for Long Island Sound resources. Information gained will allow scientists and managers to assess more effectively the status of important stocks and manage Sound resources. Included among the tasks in this study will be an analysis of trends in stock sizes as a function of pollution levels, natural environmental variation, and fishing.

#### Synopsis of the Distribution of Selected Long Island Sound Fish and Shellfish

In addition to the above-described stock assessment work, NOAA scientists are analyzing data on important Long Island Sound species (by life stage) to determine their distribution and density throughout the Sound. Analyses include descriptions of the temporal and spatial distributions of particular life stages that often strongly influence stock fluctuations. This project is being funded in part by the Long Island Sound Study.

#### Comparison of Fishery Declines in Estuaries of the Northeast

For purposes of comparison, NOAA scientists examined the relationship between the level of pollution and the response of fish and shellfish stocks in five Northeastern estuaries, including the Connecticut River. Using historical data, hypotheses were developed to examine possible relationships between pollution and the health of local fisheries. This study concluded that for some species in some estuaries, after allowing for fishing pressure and climate, annual stock size trends are correlated with measures of human activities such as demographic trends, dredging activities, sewage inputs, and dissolved oxygen levels. An attempt now is being made to develop historical records of specific chemical discharges, and relate them to the fishing- and climate-corrected stock data.

## Grants to States for Fisheries Work

NOAA has provided funds to Connecticut and New York under the Grant-In-Aid for Fisheries Program (P.L. 88-309/P.L. 89-304) since 1966. Currently, funds are being used by these states for studies that include investigation of lobsters in the Sound, population dynamics of American shad in the Connecticut River, and assessment of striped bass stocks. Previous funding has been used for developing and implementing data processing programs for reporting and compiling commercial fisheries (e.g., American lobster) statistics. Earlier projects in Connecticut have addressed population biology of scup and white perch, and restoration of a commercial oyster fishery affected by a natural resource disaster. In New York, study efforts have included an historical survey of bay scallop production areas and attempts to rehabilitate, through scallop transplants, the commercial fishery in selected coastal regions.

### C. Environmental Description

#### National Status and Trends Program (NS&T)

The NS&T program was initiated in 1984 to describe the current levels and trends of selected contaminants in fish, shellfish, sediments, and water at coastal sites around the country. It is the only national program to collect consistent information on contaminant levels and fish diseases throughout the Nation's coastal and estuarine environments using standardized quality assurance procedures. Products of the NS&T program will include research reports and a national data base that will aid in the prediction of trends in pollutant levels and their effects on living marine resources. The NS&T program has two major field sampling components: Benthic Surveillance and Mussel Watch (described below). In order to have an historical baseline against which to measure the findings of these field sampling efforts, a data base is being compiled from historical studies on contaminants in coastal organisms.

#### Benthic Surveillance

For the Benthic Surveillance project, sediments and bottomfish are sampled at 50 sites around the country. Bottomfish were selected for sampling because of their close association with sediments, which tend to act as traps for contaminants entering coastal waters. Fish collected at selected sites -- including two in Long Island Sound (one in the western Sound and one in the eastern Sound) -- are analyzed for contaminants, including metals and organic and are histologically examined for tissue abnormalities. Sediments are analyzed for metals, organic contaminants, total organic carbon, and grain size. This project began in 1984 and has continued with annual sampling.

## Mussel Watch

For the Mussel Watch component of NS&T, mussels (or other suitable bivalves) and sediments are analyzed for contaminant loads from 150 sites nationwide. Mussels were selected because of their sedentary nature, and because they filter food and associated contaminants from the water column. In addition to contaminant loads, the bivalves are examined for visible and histopathological abnormalities. Six mussel watch sites in Long Island Sound will be sampled routinely. During 1986, the first year of sampling, the Long Island Sound Study funded collection of data at three additional sites.

## Charting, Tide Gauge, and Hydrographic Work

Since 1884, NOAA has been charting coastal and oceanic waters, providing an invaluable and essential service to mariners. Long Island Sound is covered by several Charting and Geodetic Service nautical charts as well as by bathymetric and topographic/bathymetric maps. To prevent accidents, the location of wrecks and obstructions is periodically updated with wire drag and sidescan sonar surveys. Another product used by Long Island Sound mariners is the Coast Pilot (Cape Cod and Sandy Hook), which provides information on a variety of these standard products. Occasionally special projects are undertaken, including a planned shoreline mapping project for the western end of Long Island Sound, as described above.

To provide information on tidal levels essential to the mariner, a network of four tide gauges are being operated in Long Island Sound; they are located at New London, Bridgeport, Port Jefferson, and Willets Point. Every year, data collected by these tide gauges are used to produce two reports entitled (1) Tide Tables, East Coast of North and South America and (2) Tidal Current Tables, Atlantic Coast of North America.

## III. ESTUARINE RESEARCH

The review and synthesis of data gathered in the characterization phase helps to identify areas where additional research is needed to support management decisions. NOAA's research activities in Long Island Sound emphasize the health of local fish and shellfish populations and physical processes.

Some of the projects described below are conducted by NOAA scientists, and some are conducted by academic researchers. The latter are funded to conduct research through NOAA's National Sea Grant College Program and are referred to below as NOAA funded scientists.

## A. Living Resources

### Growth and Reproduction of Winter Flounder and Hard Clam

One of the most urgent questions asked by environmental managers today is whether contamination is affecting living marine resources, and, if so, in what way. To address this question for Long Island Sound, NOAA is examining the reproductive potential of two of the Sound's most important resources -- winter flounder and hard clam. Laboratory and field studies are underway on the growth and reproductive potential (e.g., egg viability and production, sperm mortality, fertilization, and hatching success) in local populations of both species. Because the western Sound is perceived as having higher levels of many pollutants and a lower oxygen content in the summer months, an east-west comparison of stations and their animal populations is being examined as well. This work is being supported partially by the Long Island Sound Study.

### Estuarine Studies on Growth and Reproduction of American Lobster

The objective of this project is to study the effects of various pollutants -- including metals and PCBs -- on American lobster. Factors being measured include viability of eggs, hatching success, molting success, growth, and survival. In addition to laboratory studies in which animals are exposed to pollutants, lobsters from both clean and contaminated regions of the Sound are being collected and analyzed.

### Life History Studies of the Hard Clam

The hard clam, (*Mercenaria mercenaria*) is an important commercial and recreational fishery resource along the Atlantic coast of the United States. To realize the full potential of the hard clam resource, an understanding of the factors that govern its biological productivity is necessary. Sustainable wild-harvest fisheries depend on natural recruitment to replace the exploited stock. Recruitment of clam larvae from the water column is determined by several processes, ranging from natural factors such as predation, food availability, and substrate type to anthropogenic factors such as pollution stress. These recruitment processes are being investigated by NOAA scientists to determine the long-term potential of clam resources, and their robustness to fishing and pollution stress. Recruitment processes are most easily studied during the benthic stage when hard clams are sessile. Laboratory work includes studies of reproduction, and abiotic influences on larval and early post-settlement success. Field work, primarily in Long Island Sound, concentrates on developing methods to grow hatchery-produced shellfish seed to market size and includes work on predators, density effects, and biotic and abiotic impacts on

survival and growth. Future work will identify natural recruitment processes for shellfish stock enhancement. The hard clam life cycle is similar to that of most valuable bivalve molluscs. Therefore, this study should serve as a model for future research on other species such as surf clams, sea scallops, soft-shell clams, and oysters.

#### Occurrence of Bacterial Pathogens of Oyster Larvae

Oysters are another important shellfish resource in Long Island Sound. The success of oyster stocks, as well as many other bivalves, depends strongly on recruitment of healthy larvae from the water column. One of the factors that can affect the health of bivalve larvae is bacterial infection. Past studies have shown that approximately one percent (4 out of 464) of the total bacterial samples taken in surface and bottom waters, and in sediments were pathogenic to developing larvae of the oyster (Crassostrea virginica). To determine how important this problem currently is in Long Island Sound, NOAA researchers are conducting a monthly series of sampling cruises in the Sound to collect data on seasonal shifts in bacteria over shellfish beds. Sampling stations are located in commercial shellfishing grounds in New Haven, Stratford, Bridgeport, and Norwalk. In addition to bacterial samples, water is analyzed to determine pH, dissolved oxygen, temperature, and salinity. The results of this work should provide information important to shellfish managers concerned about maintaining healthy, harvestable populations.

#### Effects of Pollution on the Development of Fish and Shellfish

Many of the most common environmental pollutants can have adverse effects on genetic processes that are essential to the viability of eggs and larvae. One of the genetic processes affected by pollutants is chromosome division, which affects hatchability of eggs. Because abnormal chromosome division also can be quickly and easily observed, it is a good and highly sensitive indicator of the effects of environmental contamination on fish and shellfish reproduction. In conjunction with other NOAA studies on the health of winter flounder, eggs of flounder caught at various sites in Long Island Sound are being examined for evidence of chromosome damage. This project is being partly funded by the Long Island Sound Study.

#### Somatic Mutations in Fish

In conjunction with the above-described study of chromosome damage in eggs and larvae, adult winter flounder are also being studied for evidence of chromosome mutations in their blood.

Similar studies are planned for the hard clam, as well as a study on the American oyster that is intended to elucidate any synergistic and antagonistic effects of PCBs, aromatic hydrocarbons, temperature, and salinity.

#### The Relationship Between Oceanic Spawning and Recruitment of Juvenile Bluefish to the U.S. Atlantic Coast

The link between bluefish spawning areas on the continental shelf to recruitment of juveniles to particular inshore nursery grounds along the U.S. east coast has not been well established. NOAA funded Sea Grant scientists are investigating this problem by determining the relationship between geographic areas of spawning, spawning season, and recruitment of juveniles to coastal bays and estuaries. This information will be useful to fishery managers concerned with controlling fishing effort and forecasting recruitment in the popular Long Island Sound recreational and commercial fisheries for this species.

#### Seafood Science

In addition to work on the biology and ecology of fishes and shellfishes, NOAA is funding studies using these resources as seafood, including investigations into how to maintain the quality of fresh and frozen finfish, how to extend the shelf-life of seafood products, what role lipids play in the nutritional and quality attributes of seafoods, and how surimi can be used in product development. Other investigations include the potential use as convenience foods of selected non-traditional species of fish and other seafood and the usefulness of improved technologies for seafood handlers and processors.

#### Mariculture

As the demand for seafood continues to rise -- and the quantity of harvestable stocks remains stable or declines -- culturing of shellfish and other organisms becomes more and more economically feasible. NOAA and Sea Grant scientists have conducted a number of studies in which they have refined our knowledge of the suitability of various species for aquaculture, and have developed new techniques for growing them. Below are descriptions of some of these products.

#### Demonstration of Commercial Clam and Oyster Mariculture: A Cooperative Approach

Although interest in commercial clam and oyster mariculture is high, questions remain as to its economic feasibility. To resolve these questions, NOAA funds researchers to evaluate the construction and operation costs of shore-based and field

nursery systems. In addition, they are documenting performance in terms of growth and survival of juvenile clams and oysters. They also are testing alternative nursery systems and sites, with emphasis on costs, predator control, growth, and survival of juvenile clams and oysters. Last, the researchers are documenting the quality of the final grow-out systems in terms of cost and performance, as measured by juvenile growth and survival.

### Diets of Suspension-Feeding Bivalves

To assist in understanding why some coastal areas are naturally productive shellfish growing areas and some are not, NOAA funded scientists are studying the diets of shellfish that feed on food carried in the water column. The information produced by this study can be used by culturists in selecting optimum growing areas for culture facilities.

Researchers already are investigating some growing areas for their suitability for large-scale aquaculture, including bottom waters in coastal areas. The suitability of this region for culturing bivalves is being measured by the relative growth of bivalves exposed to this organically-rich, turbid environment. In this study, growth rates of hard clams (Mercenaria mercenaria), oysters (Crassostrea virginica), and surf clams (Spisula solidissima) positioned at several depths above the bottom of Long Island Sound are compared, and the food available at that site measured.

### Growth Reproduction, and Culture of the Bay Scallop (Argopecten irradians)

Bay scallops are among the most commercially important shellfish in waters bordering Long Island Sound. Traditionally, animals are harvested from the wild, but interest in culturing is on the increase. Researchers are studying scallops to determine whether the culture environment can be manipulated to maximize growth of the adductor muscle, which is the only part of the bay scallop that currently is marketed.

In addition to manipulating the culture environment, a new and rapidly-developing area of aquaculture research is in the genetic manipulation of organisms to produce desired characteristics. In an ongoing Sea Grant project, researchers are attempting to develop a reliable procedure for creating gynogenetic homozygous clones of bay scallops. Creation of these clones would permit the production of large quantities of seed scallops with desirable production characteristics, such as large adductor muscles. The high growth efficiency and uniformity of such seed would be practical for management of wild scallop stocks as well as for improving the production



efficiencies of commercial scallop culture systems. One objective of this study is to assay the growth and reproduction of laboratory-produced clones relative to wild stock.

In the field, bay scallop populations are highly variable because of periodic catastrophic mortalities among juveniles. NOAA funded scientists are conducting several studies on scallop larvae to settle out of the water column onto the seafloor. Also being investigated are the dynamics of scallop populations and the dependence of juvenile scallops on eelgrass beds. The information collected in these studies will be of use to fishery and environmental managers as they attempt to maximize production from the bay scallop resource, and to culturists seeking to maximize survival in culture systems.

#### Settlement and Early Postlarval Survival of the Soft-Shell Clam (Mya arenaria)

NOAA, through Sea Grant is studying the factors that cause young soft-shell clams (Mya arenaria), to settle and grow. The results of this study may be used to enhance settling and survivorship rates on natural Mya beds as well as in the establishment of public or private culture facilities for this species.

#### Behavior and Behavioral Modifiers of Important Shellfish Predators: The Crabs Neopanope sayi and Ovalipes ocellatus

One of the most economically important species in Long Island Sound is the hard clam (Mercenaria mercenaria). There has been substantial interest in culturing of these clams to enhance production, but one of the problems facing culturists is predation on small clams by crabs. To address this problem, the researchers are studying crab predation and identifying potential techniques to alter the behavior of these predators in a manner that offers protection to cultured and natural stocks of juvenile bivalves.

#### Aquaculture of Seaweeds

The fast-growing brown algae (Laminaria longicruris) has been proposed as a harvestable source of biomass that can be used in energy production. NOAA funded scientists in Connecticut and New York are collaborating on a study in which they collect wild plants from the Sound and subject them to controlled cultivation in greenhouses. Environmental requirements for maximal growth of this species will be identified, thus providing the information necessary for evaluating the feasibility of commercial cultivation. Nitrogen is the nutrient that is generally most limiting to growth of seaweeds in the Northeast. Because of this, researchers also are investigating development of nitrogen-

fixing bacteria strains that remain active in spite of high water nitrogen concentrations. The results of their work can be used to maximize production of seaweed biomass in culture systems.

In addition to their use in energy generation, seaweeds can be cultured for production of chemicals and pharmaceuticals. This potential has attracted substantial interest on the part of scientists and industry. Scientists currently are investigating methods for growing another seaweed that appears suitable for use as a cultured crop -- Laminaria saccharina. Among other activities, they are seeking to produce a superior strain of the seaweed that has enhanced growth as well as optimal characteristics desirable in a harvestable crop.

#### B. Physical Processes

##### A Study of the Processes of Movement, Mixing, and Exchange in the Peconic/Flanders Estuarine System

Connected to Long Island Sound at its eastern extreme, the Peconic Bays system is being subjected to increasing development pressure. NOAA is also funding Sea Grant scientists to study the physical dynamics of water movement in the system, which is crucial to present and future studies of water quality in the region. Among other projects, the exchange between the Peconic Bays system and adjacent water bodies is being determined.

#### IV. ESTUARINE MANAGEMENT

NOAA's programs and activities encourage wise management of the Nation's estuarine resources. NOAA administers programs and grants that help manage the Nation's marine fisheries, protect valuable marine and estuarine habitats, and balance coastal development and conservation activities. NOAA also provides expertise to Federal and state agencies that have management or decision-making responsibilities for coastal resources.

#### A. Living Resources Management

##### The Economics of the Long Island Recreational Fisheries

The recreational fishery in Long Island Sound is very important to the local economy. To maximize the long-term benefits from these recreational fishery resources, fishery managers need a tool to accurately determine the magnitude of the fishery. To provide such a tool, NOAA funded scientists are conducting an economic analysis of the Long Island recreational fishery and are developing an improved approach to estimating recreational demands and valuing recreational resources.

## Life History, Modeling, and Resource Utilization of the Soft-Shell Clam (Mya arenaria)

To provide information for resource managers, the NOAA funded scientists are identifying locations of natural populations of soft-shell clams (Mya arenaria) in Long Island Sound, and are investigating their life history and rates of juvenile settlement. In addition to field studies, they are modeling responses of the animals to environmental fluctuations to evaluate various harvesting strategies. These findings will help formulate recommendations for managing Mya arenaria.

### Marine Advisory Service on Fisheries and Marine Interests

Sea Grant operates a Marine Advisory Service for commercial, charter boat, and recreational fishermen as well as other marine interests that is directed toward education, improvement of harvesting methods, increased efficiency, and savings in operating expenses. In addition, commercial fishermen are advised on seafood marketing techniques and development of underutilized species. Other programs relate to developing coastal resources and businesses in an economically and ecologically acceptable manner.

#### B. Habitat Resources Management

NOAA cooperates with local, state, and Federal agencies, and with developers involved in water resource planning in Connecticut and New York. To minimize damage to fishery resources and their habitat, NOAA reviews dredge and fill proposals, applications for hydropower development, and permits for waste discharge and construction in Long Island Sound and adjacent waters. These efforts represent a major effort to provide scientific advice to decision-makers and the public. Conservation recommendations on about 1,000 applications each year assist the agency in striving for its resource management goals for recreational and commercial species, and protected species such as shortnose sturgeon and sea turtles.

#### C. Coastal Resources Management

##### A Framework for Evaluating the Impacts of Coastal Tourism Product Mixes at the Local Level

As the population in the Northeast continues to grow, coastal areas suffer from increasing pressure to fill a number of functions, including serving as sites for tourism and recreation. Researchers through NOAA's Sea Grant program are identifying alternative tourism product mixes and associated impacts for several sites in the Northeast coastal area, and they are developing a methodology for evaluating the benefits and costs

of alternative strategies. They are incorporating this benefit-cost methodology in a decision model to determine the optimal tourism development at specific sites, and presenting the model in a format usable by local planning agencies.

#### Marine Advisory Service on Coastal Erosion

Sea Grant operates a marine advisory service that works with landowners, businesses, and local governments in areas in which the shoreline is eroding. This program informs these groups of erosion mitigation methods and helps them use that information in making decisions on coastal erosion control. In addition, this information can be used to make informed decisions about acquisition or development of coastal property.

#### D. Contaminants Management

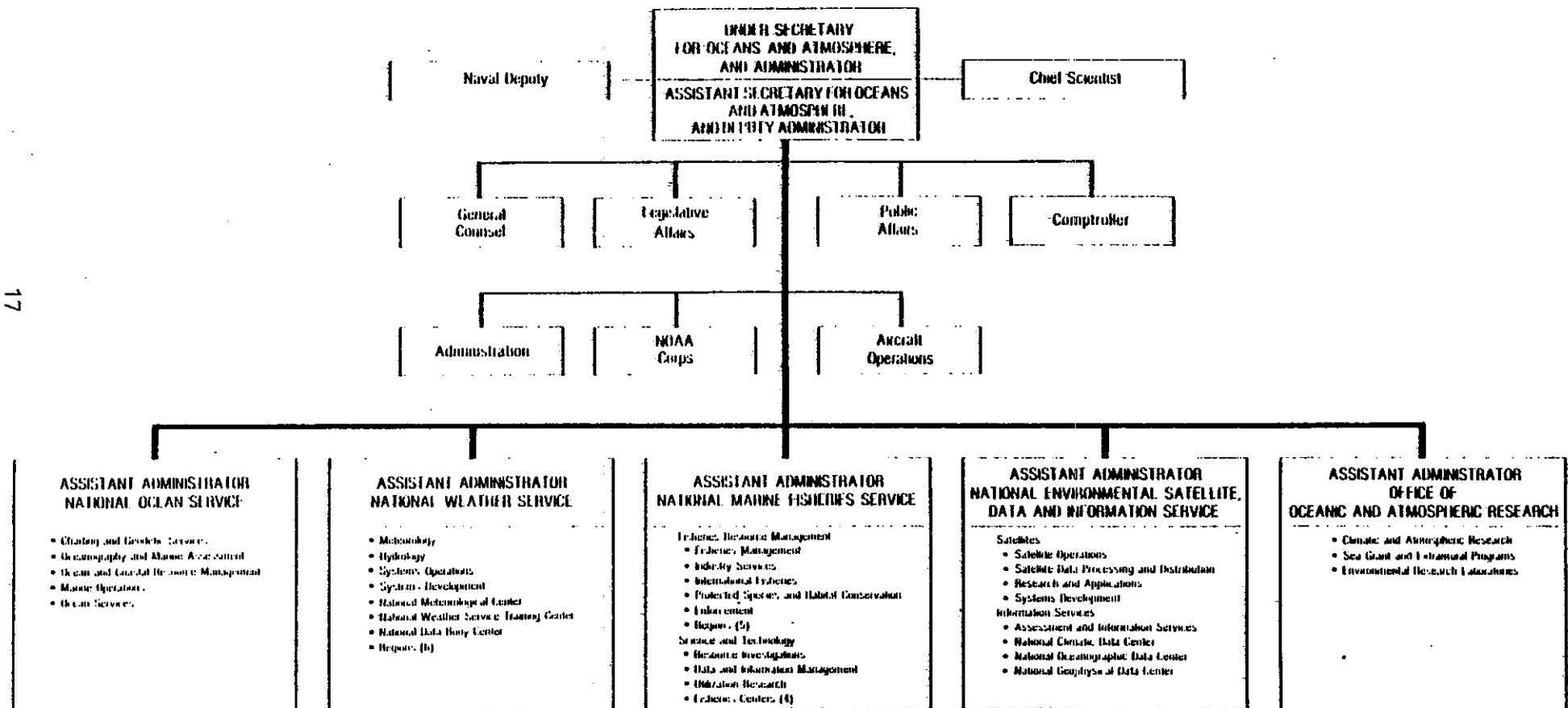
##### Geotechnical Aspects of Dredge Spoil Mass Behavior and Capping Procedures for Managing Coastal Disposal Operation

Guidelines are needed to help state and Federal managers evaluate and formulate spoil disposal plans, and compare the relative merits of alternatives for development of dredge spoil mounds. To assist these managers, NOAA sponsored researchers are studying the stability of dredge spoil mounds in the field. In addition, they are investigating potential procedures for capping the mounds with clean material to seal off any contaminants contained in the dredge spoil. Their results can be developed into methods for assessing the short-term and long-term mass stability of mounds subjected to spoil accumulation and storm wave loading. Their results will be integrated into recommendations, guidelines, and methods that can be applied to making rational decisions with regard to dredging operations and disposal.

#### V. CONCLUSION

Long Island Sound is considered an estuary of national importance. It is a productive estuary providing fisheries resources, recreational activities, and transportation lanes for commerce and trade. Because it also serves the area as a repository for industrial wastes, sewage, and dredged material disposal with degradation affects on all aspects of the estuary, NOAA maintains an active role in characterization and research to provide environmental managers with information for wise decision-making regarding estuarine activities. Also NOAA will review its ongoing programs, identify those important in addressing issues raised regarding estuaries, and recommend programs to better understand and manage the resources of the estuary.

# U.S. DEPARTMENT OF COMMERCE NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION



NOAA Organization